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Specification and Drawings, as originally filed, with Application for Patent Serial No: **2,412,109,** on December 19, 2002, by **CLAUDE CHOQUET,** for "Virtual Simulator Method and System for Neuromuscular Training and Certification Via a Communication Network".

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Virtual simulator method and system for neuromuscular training and certification via a communication network

Abstract

A virtual simulator method and system via a communication network with possible physics law respect is used to create a virtual skill training environment for dexterity fulfillment of physical activities such as professional work, labour or craft activities, sport or even physical rehabilitation requirements where the skills or neuromuscular ability is required to be performed in a precise environment. All information required insuring a code of conduct, state-of-the-art, physic laws, technical code and technique for physical activities training certification for a member are managed and maintained in a database by an online processor. This database is maintained for continuous neuromuscular training improvement updates. Access to a third party witness in this training program is allowed to ensure code, law and state-of-the-art integrity when certification is required.

Field of the invention

The field of the invention is related to professional work, labour or craft activities, sport or even physical rehabilitation requirements where the skills, dexterity or neuromuscular ability is required to performed physical activities in a precise environment with electronic tutoring systems and methods, and more particularly, to an interactive computer-based training system and method operable over an Internet Protocol (IP)-based public computer network such as the Internet, a corporate Intranet, and the like. This precise environment can be located in a online database for code of conduct, state-of-the-art, physic laws or technical code for physical activities requiring training and certification.

Background-of the present invention

Training method or devices have long been known and widely used. If the training is related to a physical activity where human skills are the main purpose of the simulator, there is a wide list of invention showing methods and devices reproducing this activity. But they are all related with an hardware simulator. The term hardware simulator is commonly used in the trade because the vast majority of simulator requires hardware tool related to software to accurately help any user to perform their physical activities requires an object to complete simulate task . Typical simulators of this type are shown, for example, in the following United States of America patents:

6477665 Bowman-Amuah; Michel K.

6371765 Wall et al

6098458 French & Ferguson

6056556 Braun et al

6033226 Bullen et al

5320538 Baum; David R.

4931018 Herbst et al

4680014 Paton et al

4124944 Blair; Bruce A.

Though such simulators have achieved considerable popularity and possibly commercial success, there has been a continuing need for improvement. The present invention does not need any particular hardware simulator to reproduce the training environment. Its interest reside in the software control and management of neuromuscular data collected over image collection simulating environment where the skill or dexterity is a major interest to accomplish a minimum requirement by code, rule of the art or any physical function requiring minimum requirements related to neuromuscular activities.

Objectives of the present invention

By practicing online virtual certification in the Internet and the World Wide Web, it has become obvious that a technological gap exist between traditional certification and online certification. This gap is related to the fact that there is no available technology in the Internet Protocol (IP)-based public computer network such as the Internet, corporate Intranet or the like for the physical and cerebral training to accomplish a minimum dexterity required by code, rule of the art or any physical function requiring minimum requirements related to neuromuscular activities.

For example, an online 2D, 3D, near 3D visual multimedia signal and auditory signal can create an environment that could easily simulate visual inspection, non-destructive examination or destructive examination to ensure neuromuscular workmanship or craftsmanship requirements or skill training dexterity. Instead of learning by traditional manual approach a simulator method develop all the minimum requirements needed in profession, industry, field, sport or rehabilitation activities.

Objectives to implement virtual simulator method and system are also to help the trainee to learn a technique and not to cope with difficult environment. For example, in a traditional welding training center the welder trainee has first to compose with the difficult environment of the welding electric arc (eyes protection and gaseous emanations and other complex technical considerations). Also in a typical traditional approach, a trainee can easily spare a very considerable amount of money before handling very expensive material and technology.

Summary of the invention

The present invention relates to a virtual simulator method and system for neuromuscular training and certification of profession, trade, craft, sport or rehabilitation activities via a communication network and more particularly to an online multifunctional virtual training platform which implements certain predefined certification neuromuscular standards. Such method and system, which can be viewed as a service, are particularly useful for enhancing communication and exchanges between trainer and trainee seeking training with third party witnessing services for certification purposes.

Any physical activities that require a minimal dexterity requirement can benefit from this invention. For example it is common knowledge that neuromuscular skills (by opposition of neurocerebral skills) are essential for basic requirement of specialized physical activities for a professional work, labour or craft activities, sport or even physical rehabilitation.

Neuromuscular virtual online training or certification can be simulated, for example, for speed control, acceleration, strength, precision or any neuromuscular abilities related to a direct relation with physical action and neurological responses.

For example, skill ability for a profession, trade, craft or sport example could be welding. The welding ability to perform a sound weld according to code requirement is of a particular interest since it could involve safety, liability and life duration of assembled material. In the field of welding, many scientific relations between welding variables are known by experts but no relation between welder dexterity and state-of-the-art equations have been documented yet.. This approach will then minimize physical test cost. These costs could increase easily when the test material is technological (welding station, welding consumables and metal plates and specialist's time). One prototype of such a Web site is under confidential research and development in the online virtual certification site of WWW.EDUWELDING.COM, for the assignee of the present application. This site provides an example of one possible implementation of this invention. The site will have the potential to be used as an online training tool by school, association, certification bureau, consumable or equipment supplier, plant or shop. Such organisms can access updated information about the trainee member status and related information about all the steps

involved in the training and certification of this welding process trainee. The member can disclose some of this information to a third party in the course of their technical or business relationship with that member. This Web site contains a welding virtual simulator method and system able to demonstrate to a trainer or a third party the ability of a trainee. This virtual simulator method and system will also be able to help the trainer to isolate the specialized neuromuscular skills that the trainee has to practice to insure himself of good results when a demonstration of his skills will be required.

With the help of physic laws equation such as dynamic, mechanic of fluid and thermodynamic, the dexterity of the welder will then be demonstrate by an online virtual simulator method and system to a trainer, immediate superior or certification representative for learning curve demonstration or for code minimum requirements. Prior to a physical test or to an online third party witnessing operation, a database configuration with the processor will have to be performed to ensure sound weld, weld size, maximum root penetration with metal transfer mode used in conjunction will the welding parameter settings.

This virtual simulator method and system can enable any weld assembly and will fulfill all criteria of a welder test such as defined by a welding code by simply activating a computer screen signal by the multimedia device. A good example of this online neuromuscular virtual simulator method and system applied in the field of welding will be a traditional T joint assembly of a weld assembly (fig. 12) to insure efficient weld penetration and weld size achievement without other code defect such as porosity, cracks or undercut. Code compliance and trainee, trainer and/ or third party witnessing expert will received information from the virtual simulator method and system according to authorized request.

This above example of neuromuscular training for welder is described hereafter with the help of drawing sequences Fig 4 and 5.

It also serves to structure steps and processes implemented by companies for quality, cost and delay controls and other purposes. This leads to more efficient dissemination of information about the qualifications and competencies of persons being certified with the present invention. It therefore leads to a wider recognition of trainees for companies and other organizations using the invention.

In a preferred embodiment, the manual dexterity virtual simulator method and system with the third party witnessing method will involve the use of a system as described in Can. Pat. No. 2,311,685 issued to Choquet. Such a manual training is advantageous in that it permits a controlled input of essential variables to required tasks with third party witnessing certification.

Brief description of the drawings

The objects and features of the present invention will become more apparent in conjunction with the accompanying drawings:

Figure 1 is a block diagram showing a simulator system according to the present invention.

Figure 2 is a schematic diagram illustrating a manual dexterity virtual simulator method and system.

Figure 3 is a schematic diagram illustrating a system according to the present invention.

Figure 4 is a flowchart showing a general process followed by the system according to the present invention.

Figure 5 is a flowchart showing a database consulting process followed by the system according to the present invention.

Figure 6 is a flowchart showing an operation flow of the certification method for a welding scenario, an operation flow of accepting or registering a new member site and a layout example of the authentication database, according to the present invention.

Figure 7 is a flowchart showing an operation flow of certification steps & interface display for the welding scenario, according to the present invention.

Figure 8 is a diagram showing an example of a welding card holder according to the present invention.

Figure 9 is a diagram showing an example of an online welding certification checklist, according to the present invention.

Figure 10 is a diagram showing an example of a list of essential variables for welding certification, according to the present invention.

Fig. 11 is a multimedia shooting view of a PDS and it can be identified as Virtual Dexterity Simulator (VDS).

Description of the preferred embodiements

Training scenarios are retrieve from the information system database figure 1, item 2 and then processed by the neuromuscular simulator processor figure 1, item 1 to the trainee level required. The data storage will be kept in virtual database figure 1, item 3. Detailed open training database center site is described in figure 3 item 36.

A description will now be given, in detail, of an embodiment in accordance with the present invention. The present invention is not restricted by this embodiment.

Figure 4 describe a welding scenario flowchart showing a general training process followed by the system according to the present invention. The retrieved welding scenario (figure 4 , item 43) is processed online to ensure code and trainee accurate revision status. Welding training scenarios are multimedia information. Specific information about the input of welding training scenarios is shown in figure 10 and 11.

The figure 4, item 44 loop is responsible to verify the welding configuration validation with code requirement and state-of-the-art physical activities. Welding configuration, code requirements are described in detailed for the training / certification in the sequenced figure 11 to 22.

Figure 10 to 22 describe the virtual simulator method and system method interface according to a preferred embodiment related to welding training. The system has client stations connected to a server station. As shown in figure 2, each work station may comprise a computer, a monitor, an input device (e.g. a mouse and a keyboard), etc. The client station may be used for different purposes, according to the access rights allocated to the user. For example, a trainee will have rights for performing various tests but will of course have no rights to change some data like his/her test results, his/her skill level. Such rights will possibly be granted to the trainer. Other rights will be granted to the certifying third party.

Welding data sheets such as figure 10 help welding trainee to set-up their work environment to perform optimize weld results. For example this welding data sheet will be used to configure the online virtual simulator system (figure 11).

Referring to Figure 11, the simulator has an interface for interaction with the trainee. The interface can be conveniently provided by the monitor of the computer used by the trainee.

Item 102 of Figure 10 is an example of weld transverse cut. These cuts vary according to the weld preparation. Item 101 is showing a double U groove weld preparation. Different shapes can be simulated by this Process Data Sheet (PDS). A list of simulation shapes possibilities can be identified in reference named "ANSI/AWS D2.4-98, Standard Symbols for Welding, Brazing, and Non-destructive Examination" This PDS is an equivalent of a frame taken out of a animation movie such as multimedia video In other words this PDS image is an animation picture extract shot representation of a weld transversal cut with the list of essentials variables that defined it.

The interface has a first window section (items 105 to 128) in which the elements used in the test are displayed. Another window section (items 129 to 134) displays test parameters and controls for interactively adjusting them if necessary. The simulator generates these elements based on preset data retrieved from the figure 3 item 36 database. The neuromuscular processor simulator does the required calculation on time and online in response to the starting procedure set in motion by the trainee with an input device (e.g. a mouse) and produces an image (items 135 to 138) that replicates a weld bead according to the welding parameters management by the trainee.

For example, two part of metal (items 135 and 136) are assembled in a proper position and essentials variables (items 105 to 134) are settled in a proper manner to produce sound welds according to code criteria. When these essential variables are used in conjunction with a multimedia device that will allow a computer screen to receive signal (item 137) a virtual image of a weld (item 138) is obtained. This image can be processed to certify code and rule-of-the-art compliance. An unlimited application possibility of this method can be developed for any neuromuscular activities.

The objective of the trainee is to obtain a sound weld with a good management of his welding parameters. Sound weld are defined in welding code or handbook. An example of a good weld can be visualized in macrographic cut (figure 12). This result can only be viewed after destructive test and cannot be monitored during welding with conventional welding technology.

The figure 13 shows that the essential variables of the simulator system are adequately configured with the mouse cursor help  that is set in motion by an input device such as a computer mouse. For example, the present figure 13 case illustrates a simulation of the figure 12. This case is the welding set-up of 2 6"X6"X 3/8" alloy 6061-T6 aluminum plates aluminum with 0.045" diameter filler aluminum alloy 4043 in the horizontal position. The generally recognized dimensional code requirement size of the weld is minimum 6mm (1/4") with a convexity of 1/8" (3 mm) maximum and a minimal penetration of 2 mm.

Therefore with his mouse cursor , the trainee adjusts his current source to a wire speed adjustment, just like in real situation. Currently his current source is activated for 250 amps.

The trainee test acceptance criteria will be in accordance with the generally recognized code requirements.

When the trainee considers that his test set-up is adequate, he must affix the mouse cursor at the starting point of his assembly (see figure 14). As soon as he clicks on his input device in this case his computer mouse, the neuromuscular simulator processor is started and activates a time calculation required for result output. The trainee then must move his computer mouse on the plates to join contact axis to demonstrate a sound weld. Speed is one of the important criteria but the straightness of the computer mouse is also. This precision is in the millimeter range.

As soon as the trainee clicks on his computer mouse an instruction is given to the neuromuscular simulator processor to calculate a material deposition rate which coincides with an image simulating the real aluminum weld deposition. For example, this processor calculates the liquid state aluminum flow rate as long as the welder trainee will not have

release his input device trigger which in this particular case is its computer mouse. If the trainee operates in a variable bracket combination which allows him to deliver a welded zone according to the training requirements then the result will be a sound weld and considered without defect. If he does not operate according to the ideal training requirements or according to the rules of the art or the codes foreseen for that purpose, this deposited metal mass in the operating zone will have the consequence to create defects which will be visible (Figure 15).

The Figure 15 shows a start-and-stop half-distance which is known in the field of welding as the compulsory stop-departure in the middle of the weld of an assembly test. This stop-and-start zone is always a defects potential zone and the restart has to be in accordance with the code currently recognized in the field. The trainee handles the computer mouse cursor quite as he handles the welding gun trigger. He has to maintain a constant speed and aim to maintain the straightness of his path to deliver a sound weld. His 2nd start on the stop will be also visually inspected. It's because the demonstration of a stop-and-stop is also a factor of success or failure during a welder test.

The figure 16 shows that during the welding when the speed is too big or small or when the cursor is not well positioned, error messages appear "Incorrect deposition" or "Insufficient penetration ". These error messages are examples of the possible monitoring with the neuromuscular simulator. Others monitoring are possible such as "Undercut", "Porosity" or "Cold lap".

When the weld is completed (Figure 17) the neuromuscular simulator processor stops the stopwatch and allows then to compare the speed with the real case which is required according to the data banks which are available to this neuromuscular simulator processor. A trainee auto-evaluation is always possible and if he requires it a virtual non-destructive or destructive visual exam is then possible by the trainer or any other online third party required to ensure welding code requirement compliance.

The trainee can then repeat as often as he wishes it or as often as he is allowed in the training environment (Figure 18 and 19). The various results obtained (fig. 18, allow the trainer and in the third party witnesser or the certification representative to observe a

detailed quality and defects retracability report obtained according to build-up of his training program. By experimenting several times his welding parameters, the trainee build-up a learning curve (Figure. 22). The trainee can re-experiment the weld deposition as often as he wants and a learning curve file built-up as much as he build-up results.

The trainee will also see the visual test results and not visual quality (absence of defects) or defects not usually available as soon as the weld is completed. For example, the trainee will see his weld bead with root lack of penetration, insufficient weld side or weld bead convexity not according to code.

A learning curve is also available to the trainee, for the trainer or for the third party witnessing auditor if required. All or only the decision-making person will decide if the trainee is then capable to switch to the stage of the practical tests with real welding equipments and consumables.

The produced mathematical curves (Figure 21) allow to generate a big number of images or numeric signals which shall be use to improve the training program and generate also more complex functions such as the examples described below.

- Visual exams (according to acceptance criteria code)
- Non-destructive exams: (ultrasonic, X-rays, magnetic particle and liquid penetrant)
- Destructive exams: (bending, tension, fracture, macrography)
- The complete path generated could be saved and be used on a welding programmable machine for a possible repetitive use
- Ontime and online welding robot guidance with remotely located expert using existing vision system

List of drawings

FIG.-1 ELECTRONIC NEUROMUSCULAR DEXTERITY SIMULATOR BY DATA PROCESSING METHOD VIA A COMMUNICATION NETWORK FOR VIRTUAL TRAINING AND/OR THIRD PARTY WITNESSING FOR SKILLS TRAINING UNDER CODE LAW, REGULATION AND STATE-OF-THE-ART RULES.

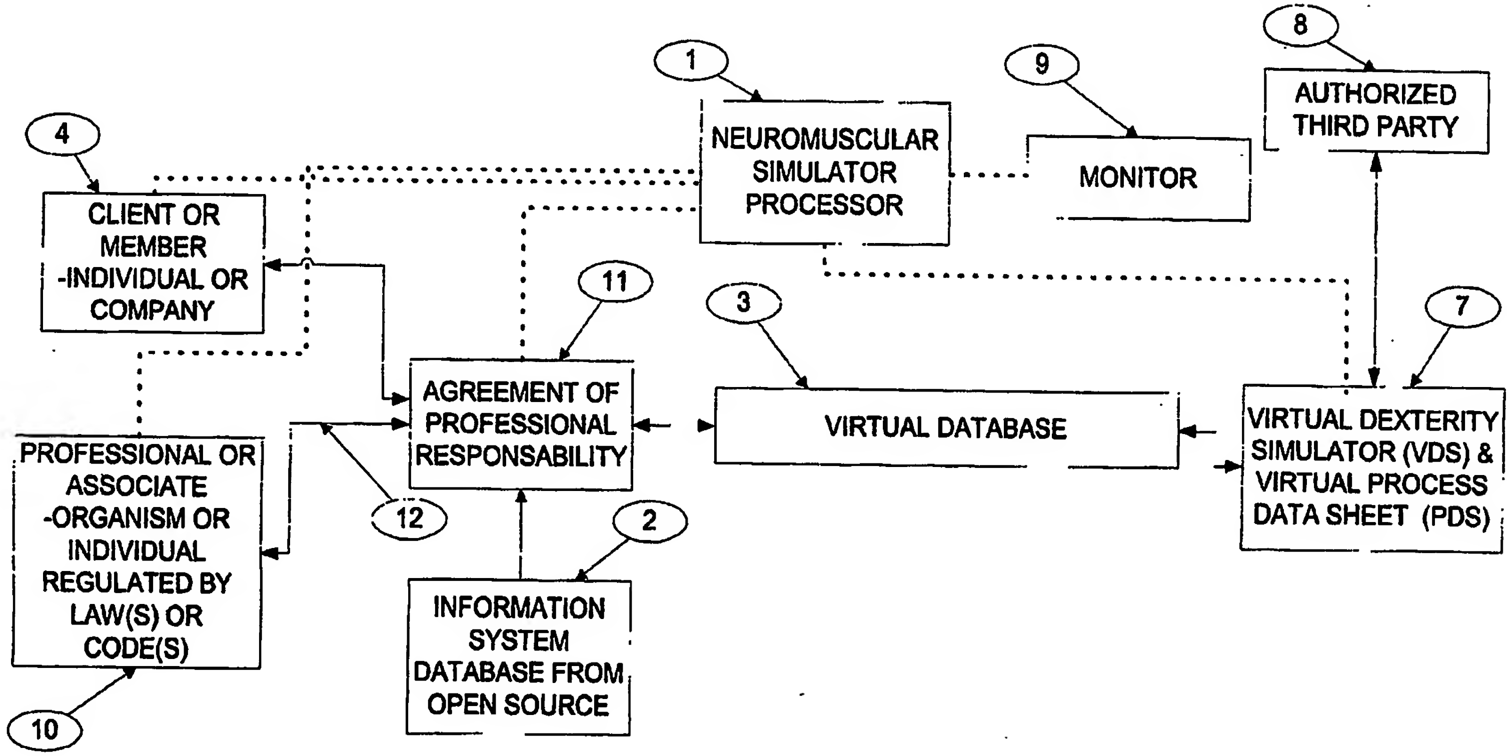

FIG.-2 A WORKING STATION WITH INPUT DEVICES (MOUSE & KEYBOARD) FOR VIRTUAL SIMULATOR METHOD AND SYSTEM VIA A COMMUNICATION NETWORK

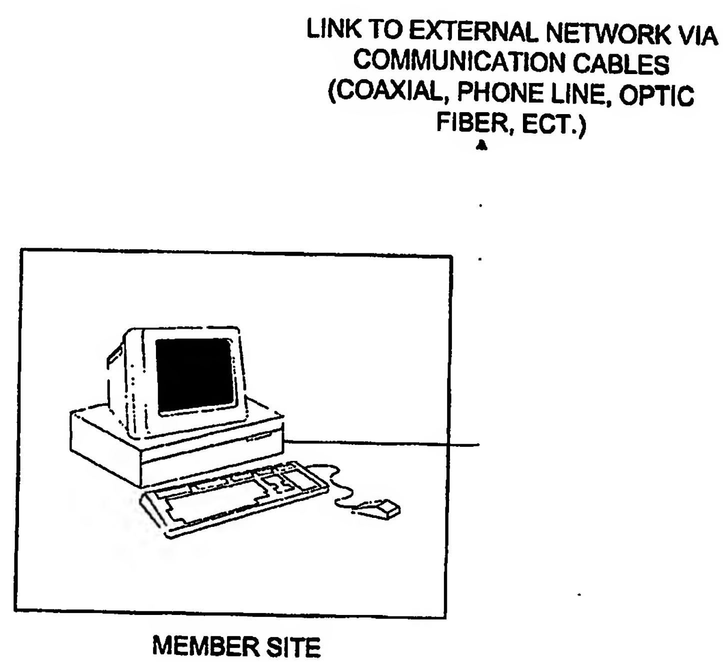

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FIG.-3 HUB AND SPOKE ALLOCATION

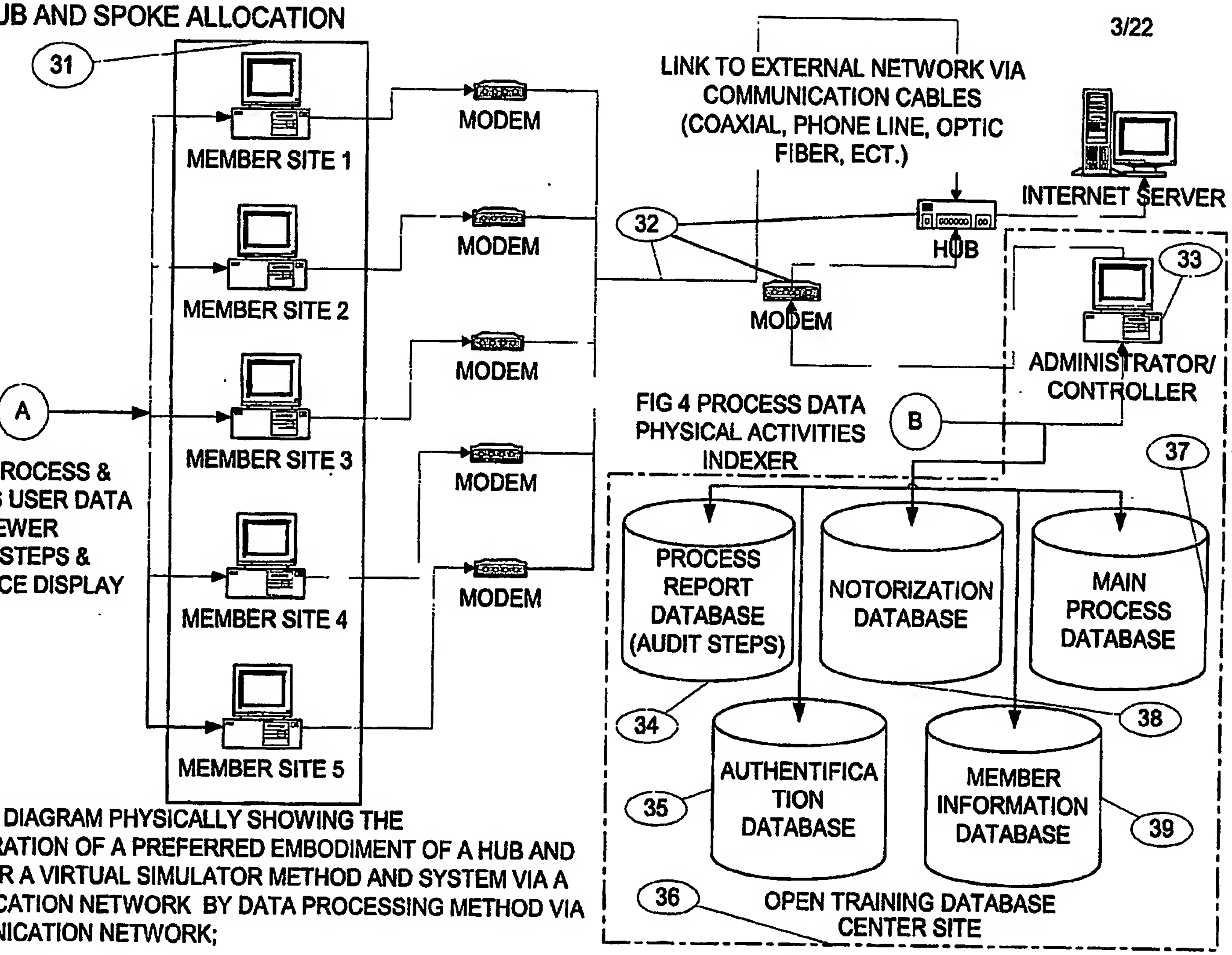

FIG.-3 IS A DIAGRAM PHYSICALLY SHOWING THE CONFIGURATION OF A PREFERRED EMBODIMENT OF A HUB AND SPOKE FOR A VIRTUAL SIMULATOR METHOD AND SYSTEM VIA A COMMUNICATION NETWORK BY DATA PROCESSING METHOD VIA A COMMUNICATION NETWORK;

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FIG-4 PROCESS DATA PHYSICAL ACTIVITIES INDEXER (WELDING TRAINING SCENARIO)

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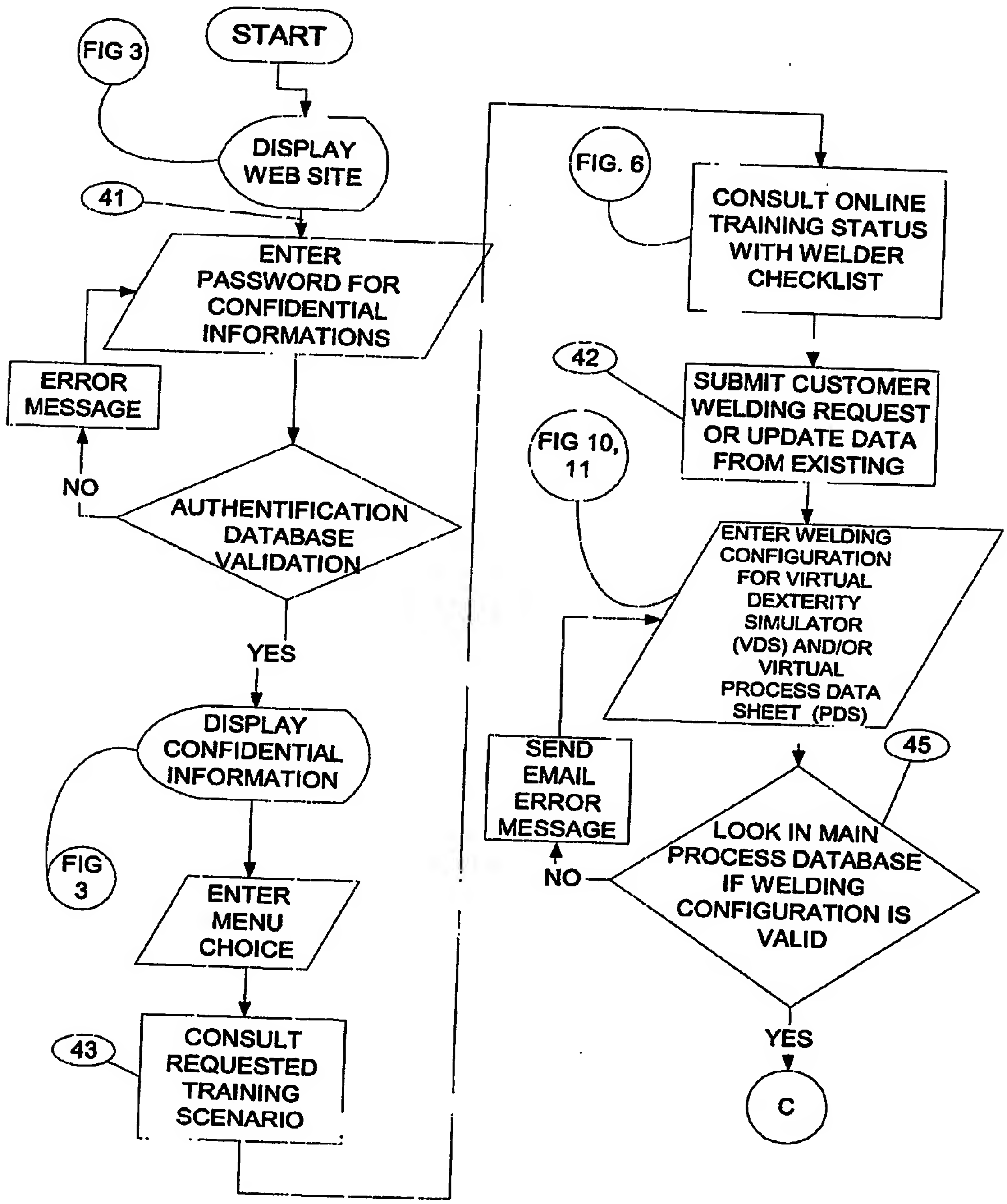

FIG.-4 PROCESS DATA PHYSICAL ACTIVITIES INDEXER (WELDING TRAINING SCENARIO) 4/22 page 2

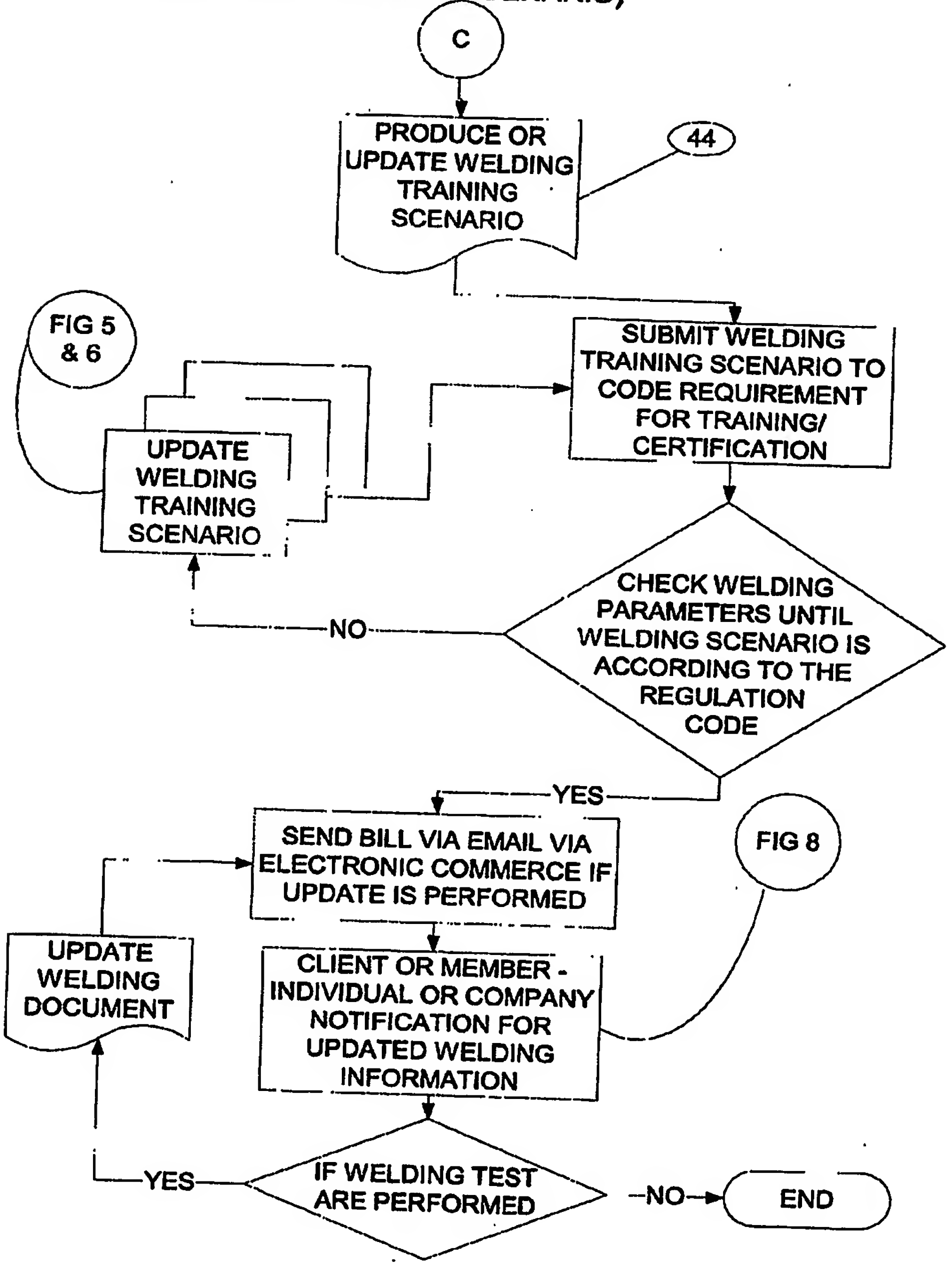

FIG. 4 IS A FLOWCHART SHOWING AN OPERATION FLOW OF THE DATA TRADE INDEXER FOR A TRAINING AND/OR CERTIFICATION, THIS METHOD IS APPLIED TO A WELDING CERTIFICATION SCENARIO.

FIG.-5 MAIN PROCESS DATABASE (WELDING SCENARIO)

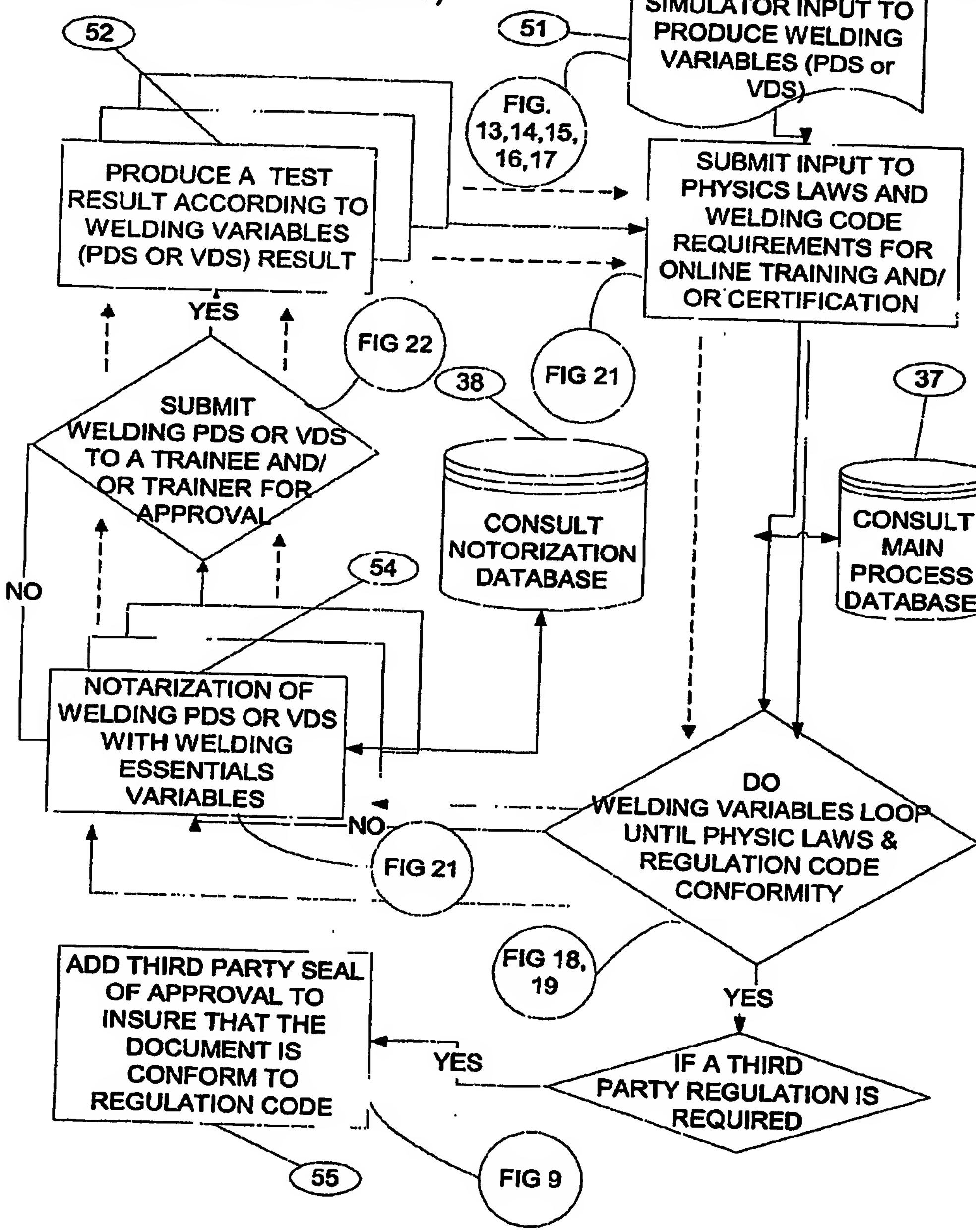

FIG. 5 IS A FLOWCHART SHOWING AN OPERATION FLOW OF THE MAIN PROCESS DATABASE WITH THE NOTARIZATION DATABASE APPLIED TO A WELDING TRAINING AND/OR WELDING CERTIFICATION SCENARIO.

FIG.-6 PROCESS & PROCESS-USER DATA VIEWER (WELDING SCENARIO)

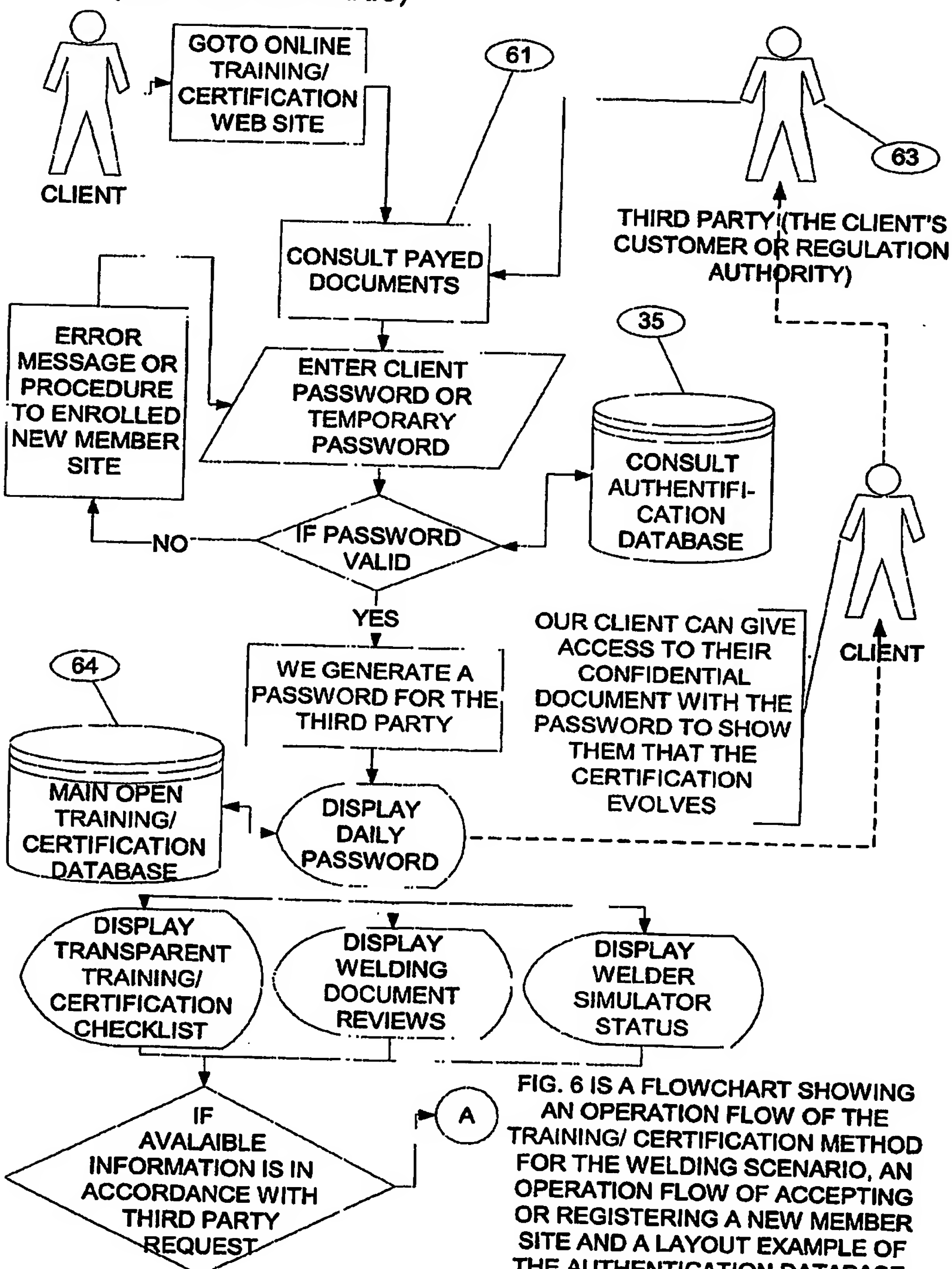

FIG. 6 IS A FLOWCHART SHOWING AN OPERATION FLOW OF THE TRAINING/ CERTIFICATION METHOD FOR THE WELDING SCENARIO, AN OPERATION FLOW OF ACCEPTING OR REGISTERING A NEW MEMBER SITE AND A LAYOUT EXAMPLE OF THE AUTHENTICATION DATABASE;

FIG.-7 CERTIFICATION STEPS & INTERFACE DISPLAY (WELDING SCENARIO)

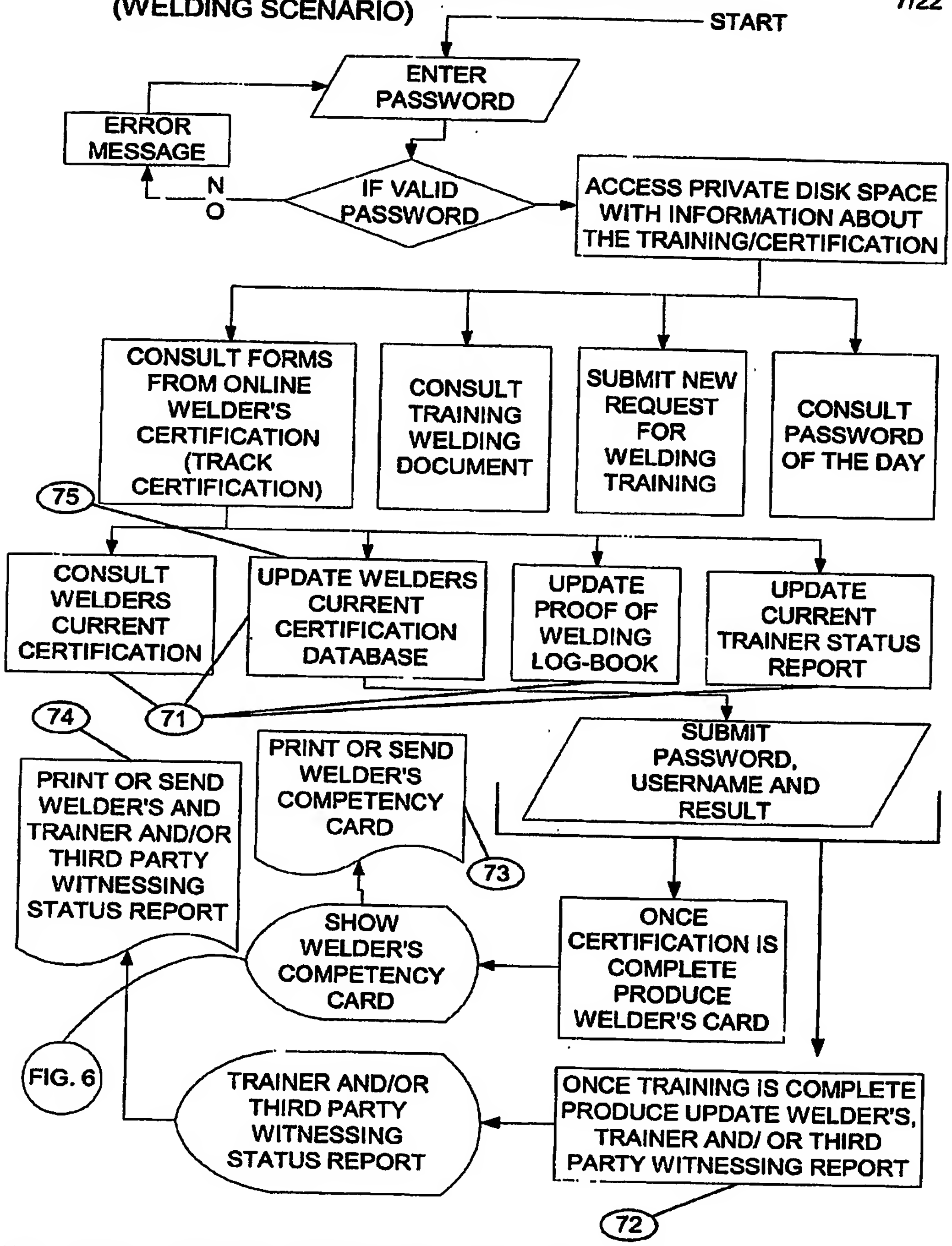

FIG. 7 IS A FLOWCHART SHOWING AN OPERATION FLOW OF TRAINING/ CERTIFICATION STEPS & INTERFACE DISPLAY FOR THE WELDING SCENARIO.

FIG. 8 EXAMPLE OF WELDING CARD HOLDER

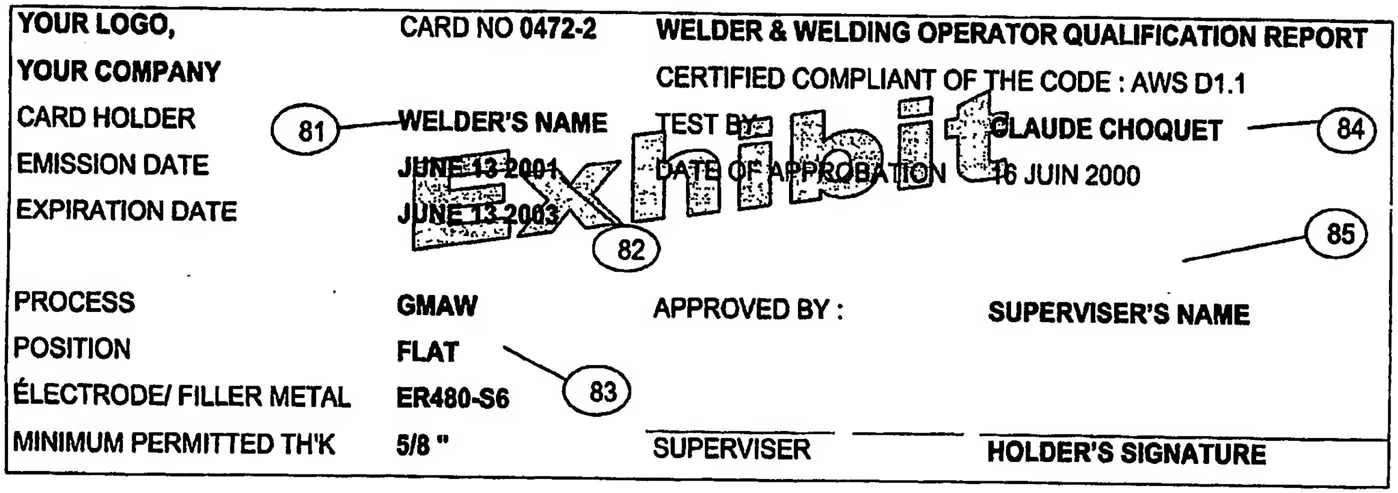

FIG. 8 IS A DIAGRAM SHOWING AN EXAMPLE OF WELDING CARD HOLDER

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**FIG. 9 EXAMPLE OF ONLINE WELDING CERTIFICATION CHECK LIST
TRACEABILITY OF WELDER TEST
SCHEDULING OF THE QUALIFICATION OF THE WELDERS
WELDING OPERATING MACHINE WELDER AND WELDING OPERATOR QUALIFICATION
TEST PLANNING SHEET**

91

92 93

EVOLUTION OF THE ONLINE CERTIFICATION			
WELDER NAME			
BASE METAL :		FILLER METAL:	
DATE :		WELDER TEST REF.:	
ITEM NO	OPERATION	RESP.	DIGITAL PRINT
1	GET THE BASE METAL ACCORDING TO THE CODE TEST	AW	UPDATE
2	GET THE FILLER METAL ACCORDING TO THE CODE TEST	AW	UPDATE
3	REVIEW THE WELDING DATA SHEET WITH THE WELDING ENGINEER	WE	UPDATE
4	PREPARATION OF THE ASSEMBLY (CHAMFERING AND TACKING)	AW	UPDATE
5	PUNCH THE ASSEMBLY	AW	UPDATE
6	GET IN CONTACT WITH THE WELDING ENGINEER	AW	UPDATE
7	VERIFICATION OF THE PREPARATION BY THE	AW	UPDATE
[illegible]	[illegible]	AW	[illegible]
16	- BENDING		...E
17	EVALUATION OF THE RESULTS	AW	UPDATE
18	ACCEPTED ☐ REFUSED ☐	WE	UPDATE
19	IF TEST BY X-RAY ACCEPTED ☐ REFUSED ☐	LABO	UPDATE
20	ASSESSMENT OF THE RESULTS BY THE RESPONSIBLE PERSON	AW	UPDATE
21	TRANSCRIBE THE RESULTS ON THE B AND D FORMS	AW	UPDATE
22	TRANSMISSION OF THE RESULTS TO THE DIFFERENT INTERVENING PARTIES	AW	UPDATE

94 95
CERTIFICATION STATUS DATED OF: 02-12-19 14:01:51
LEGEND: W: WELDER; WE: WELDING ENGINEER; AW: AUTHORIZED WORKER; LABO: LABORATORY

96

97

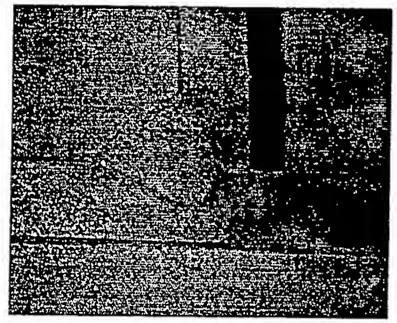


FIG 12 Macrographic cut of a real welding assembly

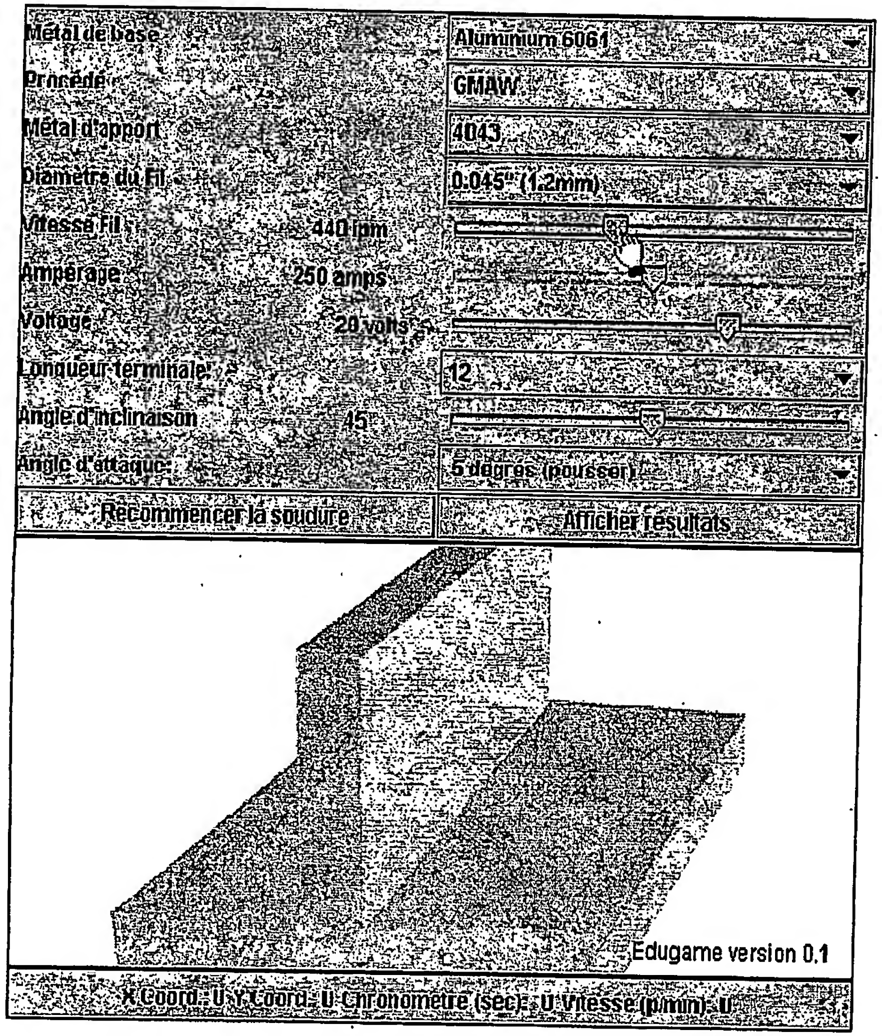


Fig. 13 Step 1 Welding parameter configuration according to welding data sheets

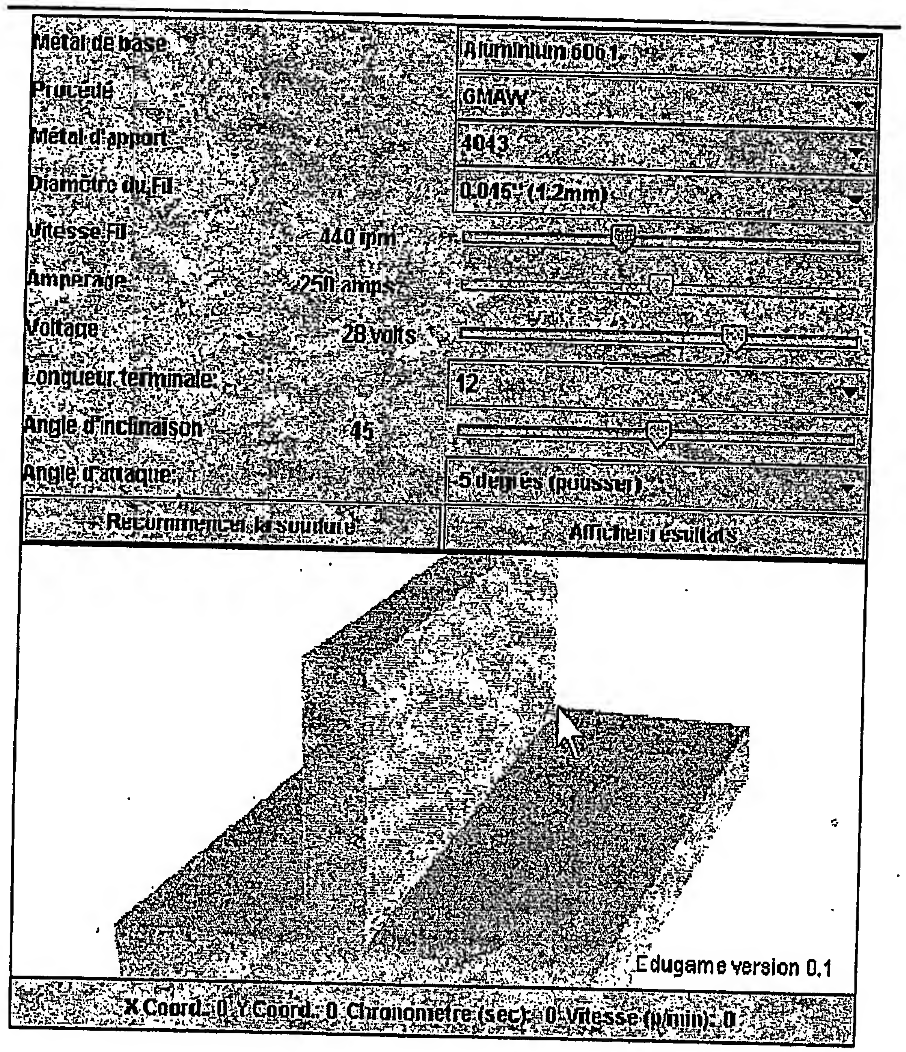


Fig. 14 Step 2 tool positioning

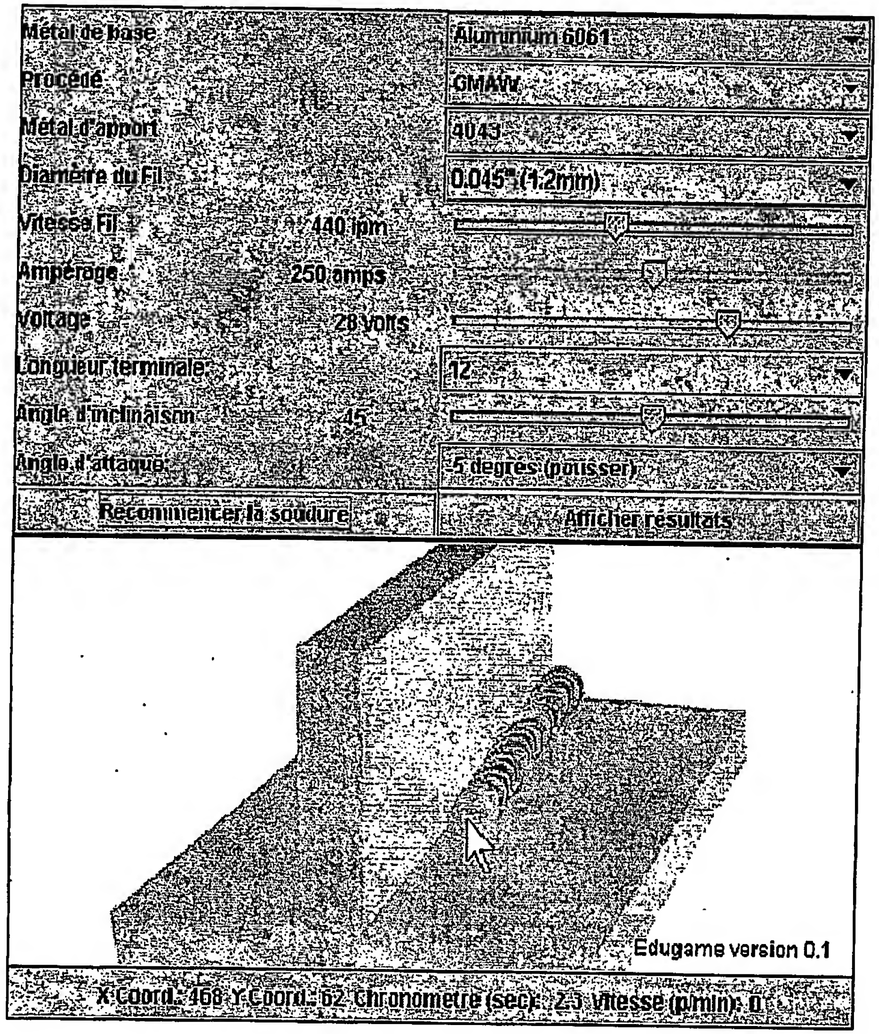


Fig. 15 Step 3 Start and stop of a virtual weld bead

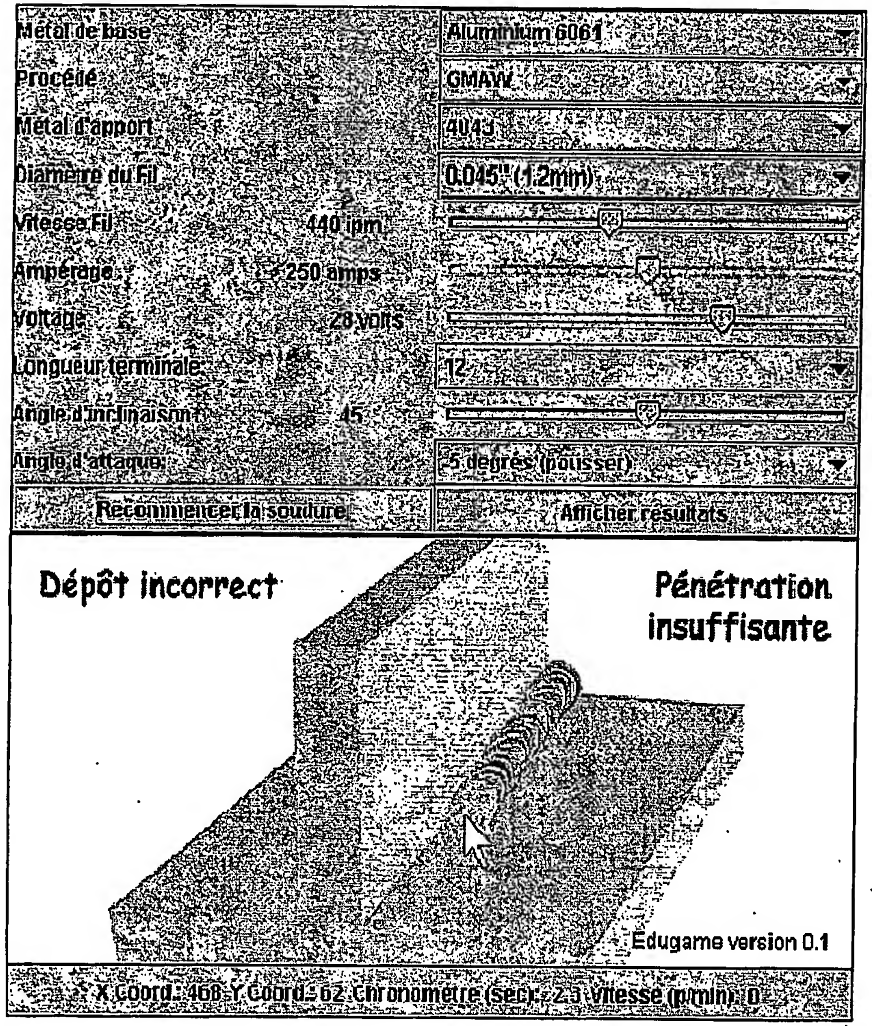


Fig. 16 Process monitoring during welding

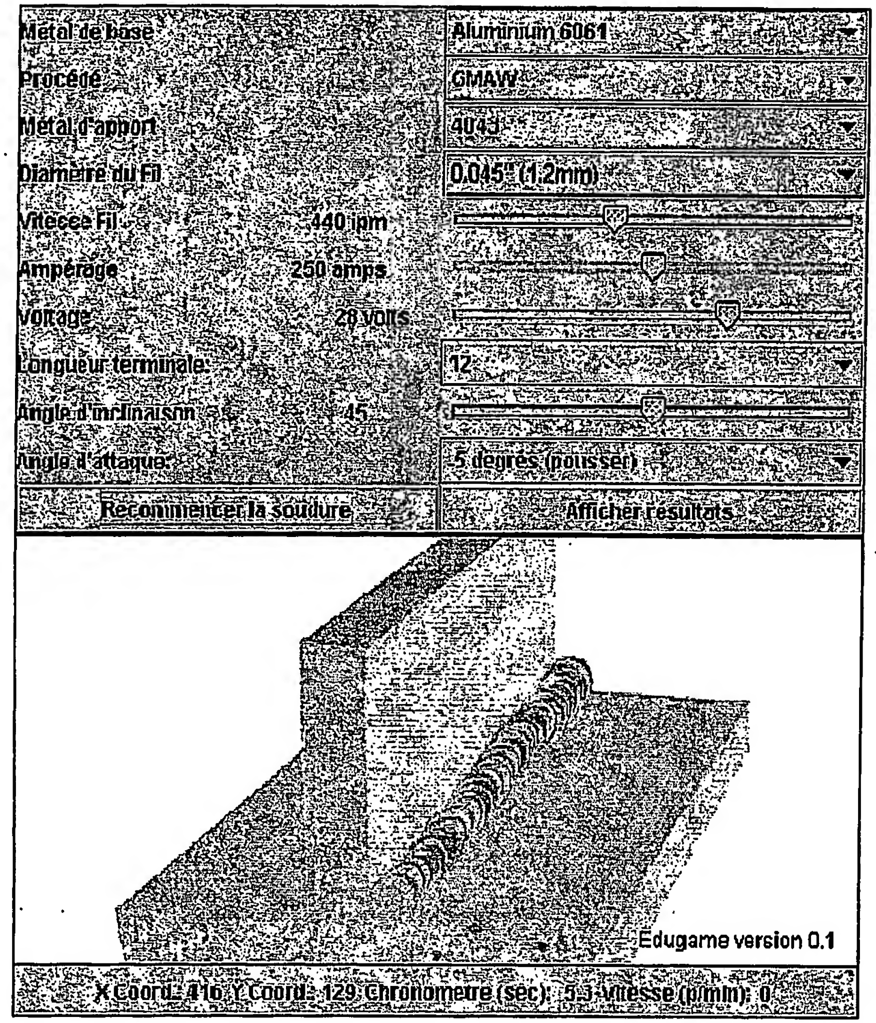


Fig. 17 Process completion

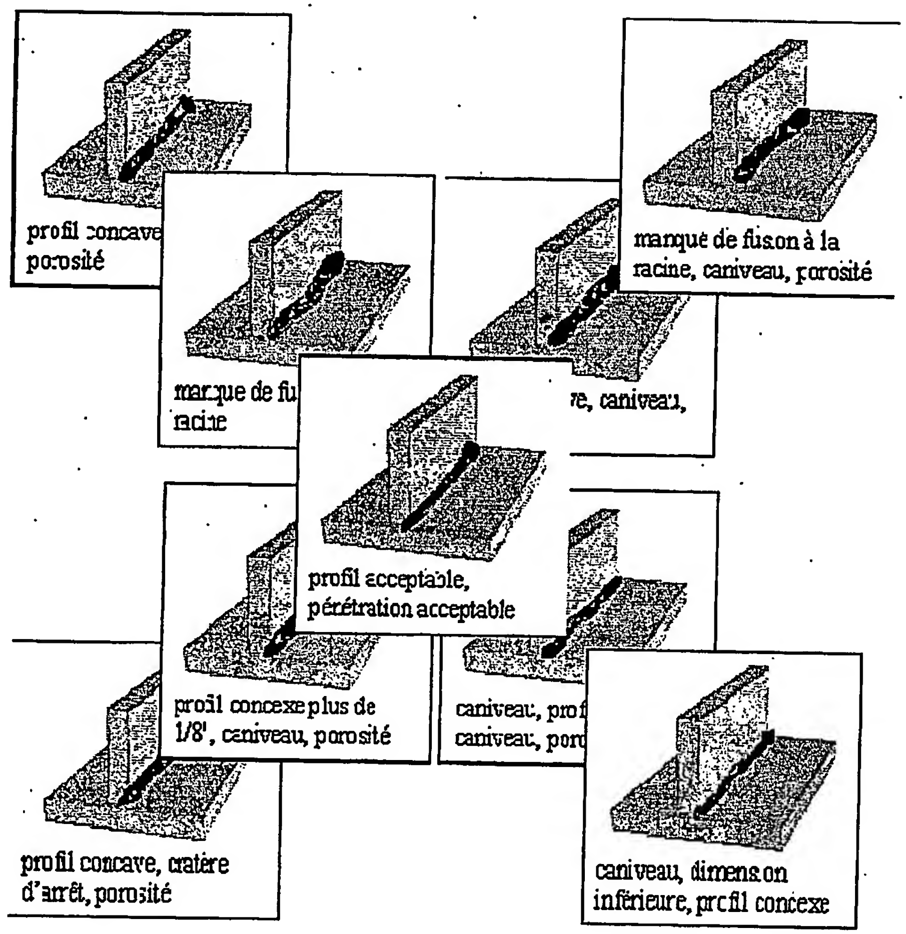


FIG. 18 Loop result of non-satisfactory neuromuscular tests

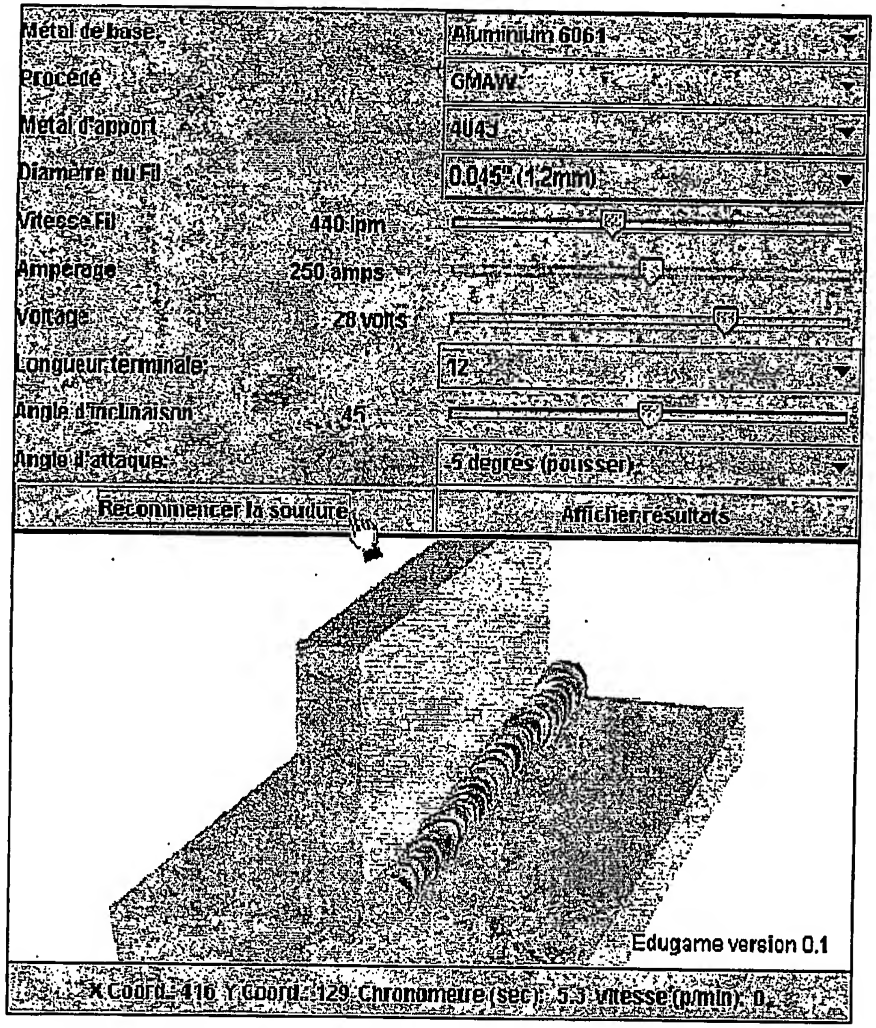


Fig. 19 Process loop until requirement compliance

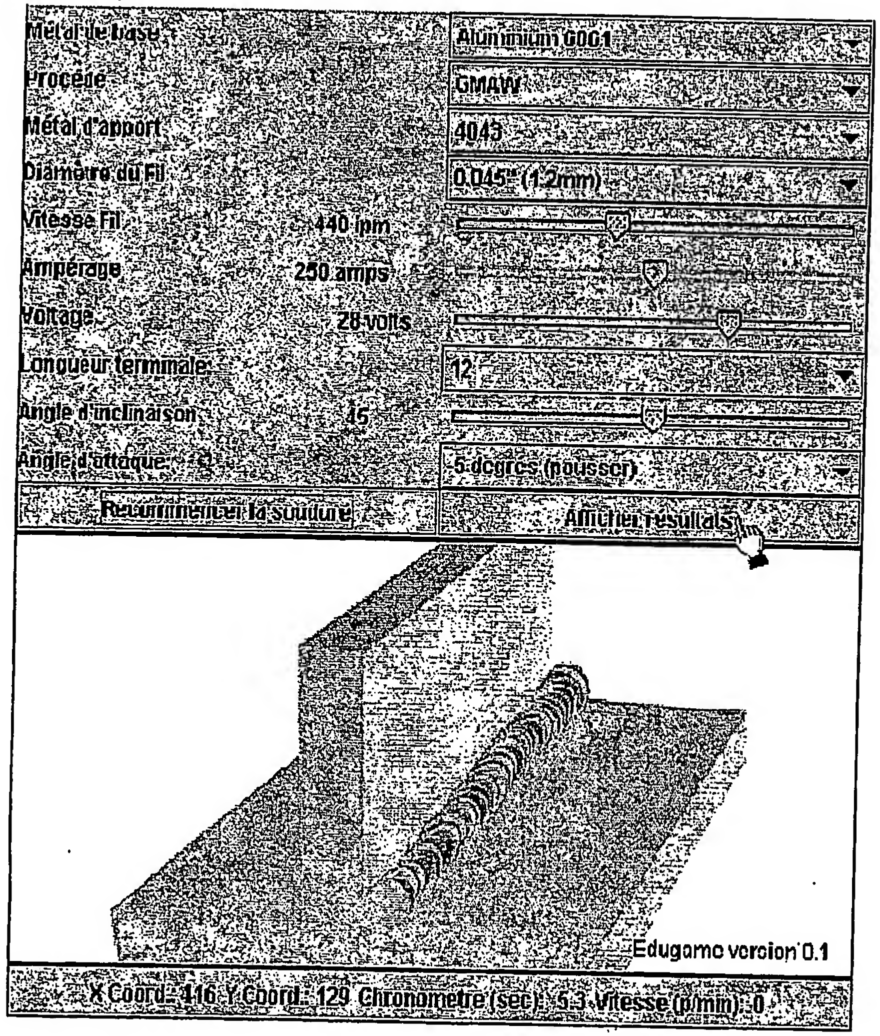


Fig. 20 visual inspection, non-destructive examination or destructive examination result of a neuromuscular test

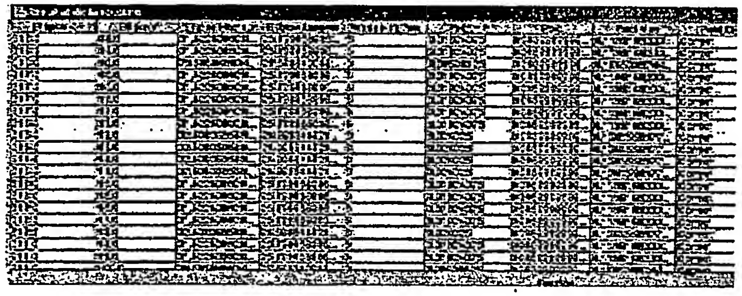
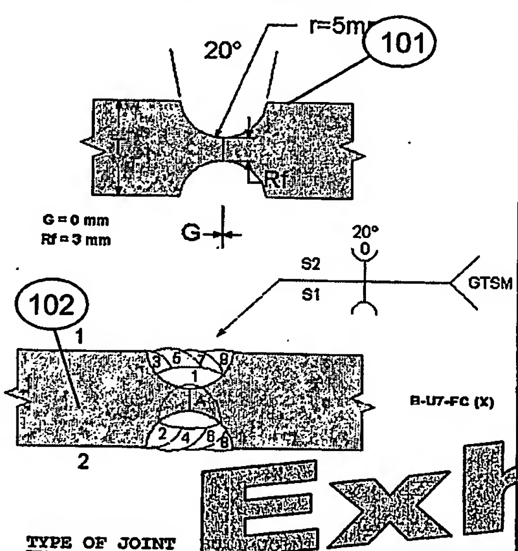


Fig. 21 Mathematical result of a neuromuscular test

FIG. 10 LIST OF ESSENTIAL VARIABLES FOR WELDING CERTIFICATION

WELDING DATA SHEET	NO: F7-1 B1 12 25-5	SECTION ...3.0...... PART .E480XT-9 CH. PAGE ....-....... DATE ...june 20 2001 REVISION ...0.......

COMPLETE PENETRATION



TYPE OF JOINT U-GROOVE WITH BACK GOUGING

MATERIAL	STEEL
BASE METAL TABLE 11.1 GR. 1,2,3, CODE CSA W59	
FILLER METAL	E4802T-9 CH
FILLER METAL-GAS COMBINATION SEE NOTE 6	
GAS: 15-25 L/MIN(35-50 CFH)	
GAS: 75% Argon + 25% CO2	
WELDING PROCEDURE	(SECTION 2.0)
PROCESS FCAW	SEMI-AUTOMATIC
CURRENT CC(ELEC +)	STICK-OUT 15-25
POSITION	FLAT
PREHEAT NONE, PAR. 2.2.10 & TAB. 5.3 W59	
BACK GOUGING	APPLICABLE

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T MM (IN.)	FIG NO	LAYER NO (2)	PASS NO (2)	ELECTRODE DIAM. MM (IN.)	AMPERES	VOLTS	WELDING SPEED MM (IN.)/MIN	WIRE SPEED (IN./MIN)	RATE DEPOSITION (LB/HRS)
15(5/8)	1 2	1 4	1 2	1.2 "	300-370 "	26-30 "	250-325(10-13) 250-325(10-13)	445	11.46
25(1)	1 2	1-3 4	1-3-5-7-9 2-4-6-8	" "	300-370 "	26-30 "	200-300(09-12) 200-300(09-12)	445	11.46
FOR ALL	2	2	A	"	"	"	200-300(09-12)	"	"

NOTE (1): THE WELDING SPEED IS GIVEN AS A REFERENCE OR A GUIDE BECAUSE IT IS FUNCTION OF CURRENT, VOLTAGE AND SIZE OF WELD REQUIRED OR DEPOSITED.

GO TO PARA 2.2.12 FOR ALLOWED RANGE.

(2): THE NUMBER OF PASSES AND LAYERS CAN BE GREATER AND IS ADJUSTED WHEN REQUIRED DEPENDING OF THE NEEDS FOR INTERMEDIATES DIMENSIONS. VOIR PARAGRAPHE 2.2.12.1 FOR ALLOWED RANGE.

(3): GO TO PARA 2.2.12 FOR THE ALLOWABLE RANGE IN VARIABLES (AMPS., VOLT, GAS).

(4) : GO TO PARA 2.2.12 FOR WELDING TECHNIQUE

(5) : THE WELDING SPEED IS AN AVERAGE VALUE FOR ALL PASSES OF EACH SIDE.

(6) : THE FILLER METAL - GAS COMBINATION MUST BE APPROVED.

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FIG. 10 IS A DIAGRAM SHOWING AN EXAMPLE OF LIST OF ESSENTIALS VARIABLES FOR WELDING TRAINING AND CERTIFICATION.

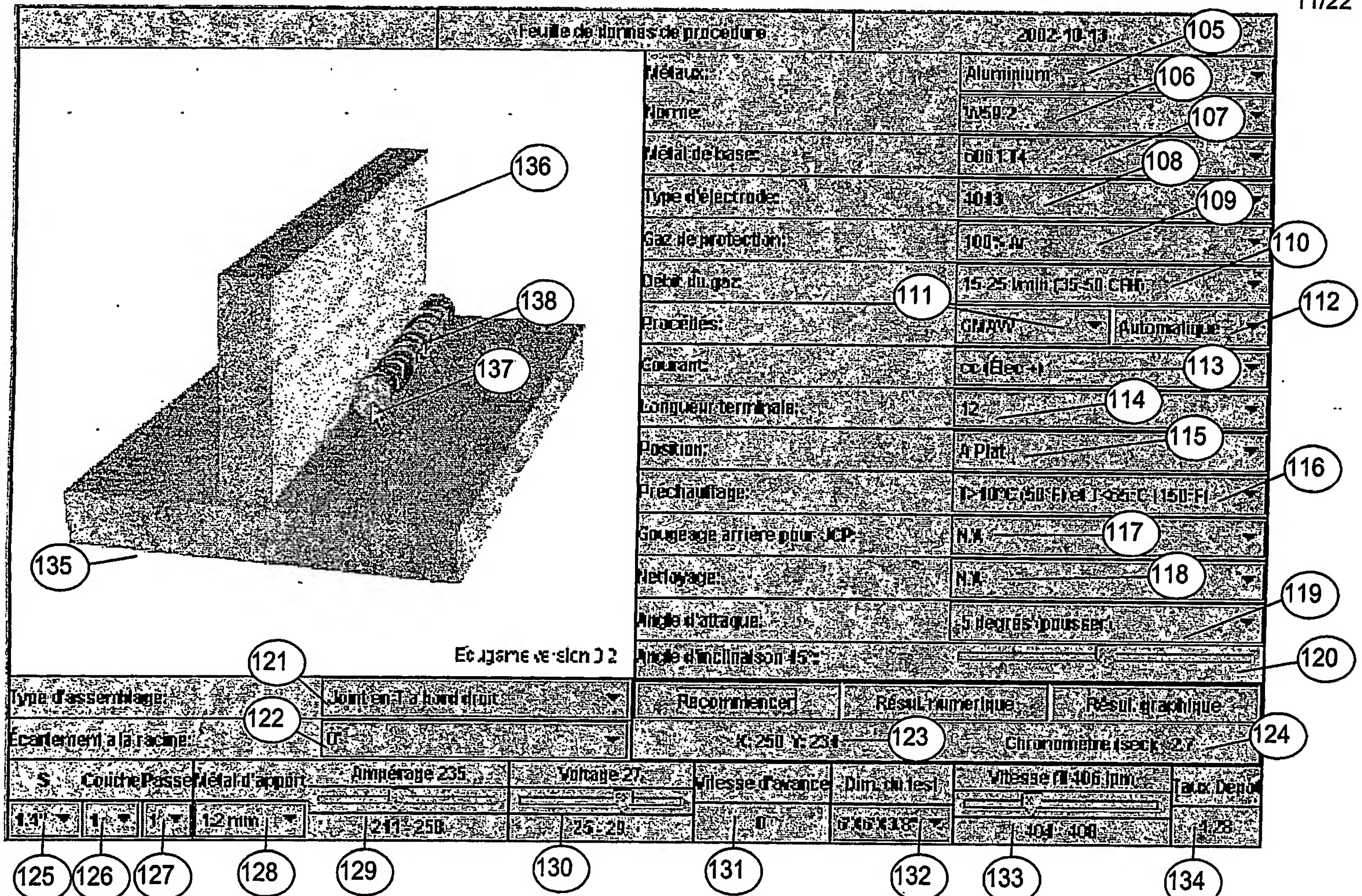

FIG. 11 IS A DIAGRAM SHOWING AN EXAMPLE OF AN EDUCATIONNAL WELDING ELECTRONIC MANUAL DEXTERITY SIMULATOR BY DATA PROCESSING METHOD VIA A COMMUNICATION NETWORK FOR VIRTUAL TRAINING AND/OR THIRD PARTY WITNESSING THE DIAGRAM IS ALSO SHOWING THE LIST OF ESSENTIALS VARIABLES FOR WELDING TRAINING AND CERTIFICATION USED IN CONJUNCTION TO PHYSICS LAWS AND WELDING CODES REQUIREMENTS.

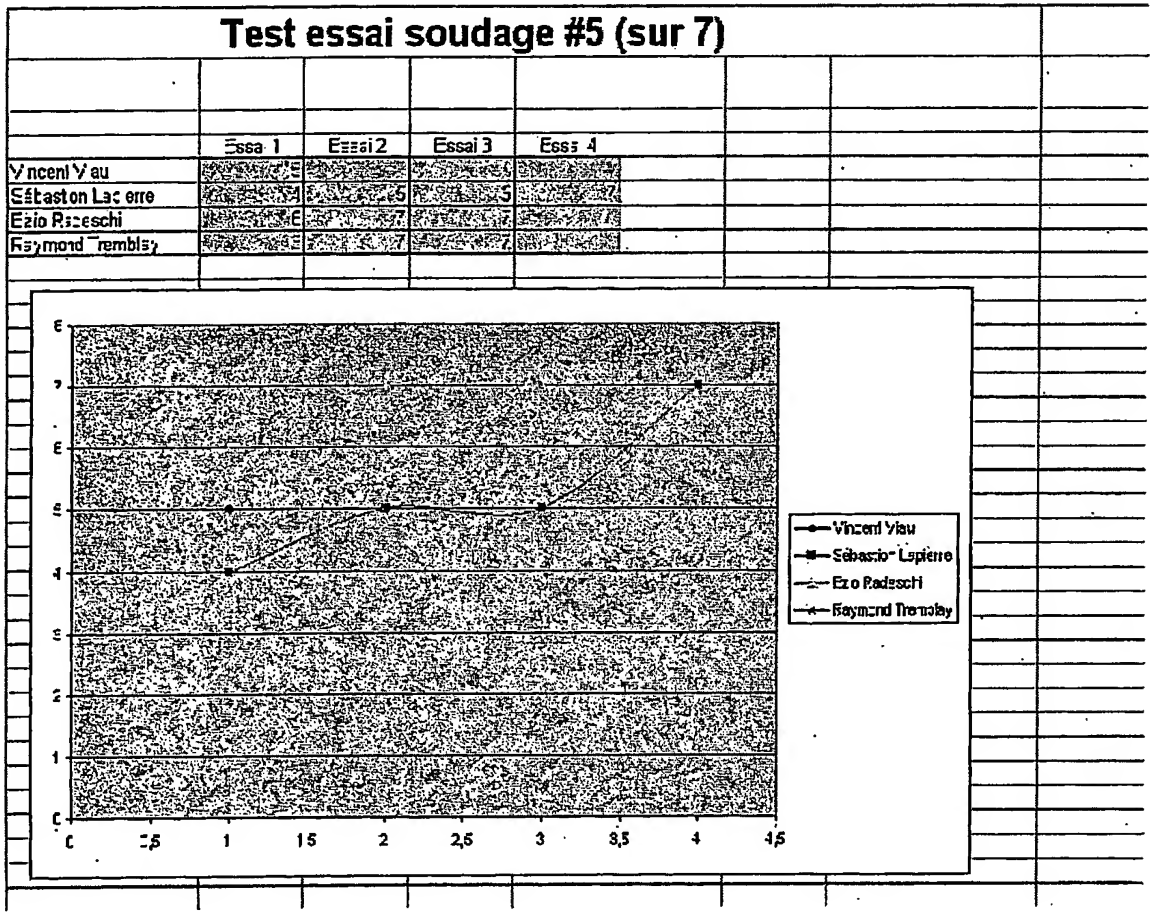

Fig. 22 Learning curve result of a neuromuscular test